GRADE 12 DIPLOMA EXAMINATION

Physics 30

June 1989

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 49 multiple-choice questions each with a value of 1 mark.

PART B: Four written-response questions for a total of 21 marks.

A physics data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. **USE AN HB PENCIL ONLY.**

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. Mathematics

Answer Sheet

A	B	C	D
①	②	●	④

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JUNE 1989

PART A

INSTRUCTIONS

There are 49 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

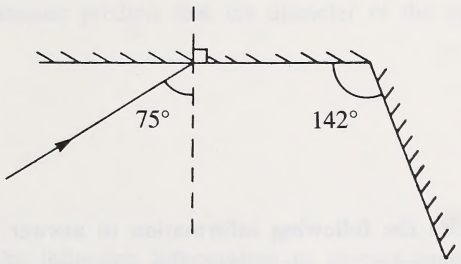
WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER

1. Two properties of light that can only be explained by a wave model are

A. interference and diffraction
B. interference and dispersion
C. reflection and diffraction
D. reflection and refraction

Use the following information to answer question 2.



A ray of light hits the first mirror and is reflected to the second mirror, from which it is reflected again.

2. The angle between the final reflected ray and the surface of the second mirror is

A. 38°
B. 23°
C. 19°
D. 15°

Use the following information to answer question 3.

I. Light is a transverse wave.
II. Light is a longitudinal wave.
III. Light is always polarized.
IV. Polarized light vibrates in one plane.
V. Unpolarized light vibrates in random directions.

3. The wave nature of light is correctly described in statement(s)

A. II only
B. I and III
C. I, IV, and V
D. II, III, and IV

---

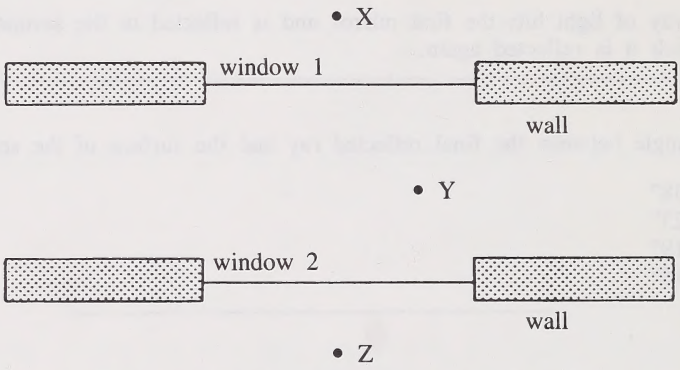
4. When they travel through the same doorway, sound waves diffract much more than visible light waves do because

A. the speed of light is much greater than that of sound
B. the wavelength of sound is much longer than that of light
C. light is a transverse wave but sound is a longitudinal wave
D. sound is a mechanical wave but light is an electromagnetic wave

5. A ray of light travels from air ($n = 1.00$) to water ($n = 1.33$). If the angle of incidence is 40.0°, the angle of refraction is

A. 58.7°
B. 53.2°
C. 30.1°
D. 28.9°

Use the following information to answer question 6.



Windows 1 and 2 are polarizing filters that have their axes at 90° to each other.

6. If people at X and Y record what they can see, the result should be that

A. X sees only Z, and Y sees only X
B. X sees only Y, and Y sees both X and Z
C. X sees both Y and Z, and Y sees only Z
D. X sees nothing, and Y sees both X and Z

7. If the frequency of light used during a double-slit experiment is doubled, the spacing of the lines in the interference pattern will be multiplied by

A. 0.25
B. 0.50
C. 2.0
D. 4.0

8. An astronomer on the planet Venus finds a maximum delay of 12 min between the predicted and the observed times that the Earth eclipses its moon. From this information the astronomer predicts that the diameter of the orbit of Venus is

A. 2.4×10^{6} m
B. 6.0×10^{7} m
C. 3.6×10^{9} m
D. 2.2×10^{11} m

Use the following information to answer question 9.

Newton's Refraction Predictions

When entering a medium from air,

I. light bends toward the normal
II. light speeds up

9. Newton's predictions were subsequently tested for light entering glass from air. The true predictions were

A. I only
B. II only
C. both I and II
D. neither I nor II

---

10. When light of frequency 6.0×10^{14} Hz passes through a grating of line spacing 5.0×10^{-6} m, it produces an interference pattern on a screen 1.0 m away. A bright image is formed 0.20 m from the central maximum. The order of this image is

A. 4
B. 3
C. 2
D. 1

Use the following information to answer question 11.

A student stated that electric charges have the following properties:

I. Two objects with like charges repel each other.
II. Positively charged objects repel neutral objects.
III. Two objects with unlike charges attract each other.
IV. Negatively charged objects attract neutral objects.

11. Which of the student's statements is contrary to accepted theory?

A. I
B. II
C. III
D. IV

---

12. A positive charge of 4.0×10^{-6} C exerts a force of repulsion of 7.2 N on a second charge 5.0 cm away. What is the sign and magnitude of the second charge?

A. $+5.0 \times 10^{-7}$ C
B. -5.0×10^{-7} C
C. $+5.0 \times 10^{-3}$ C
D. -5.0×10^{-3} C

13. The electric field between charged parallel plates is

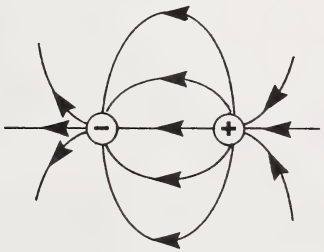
A. uniform
B. strongest near each plate
C. dependent on the area of the plates
D. strongest midway between the plates

14. At a point 0.500 m from a point charge of magnitude 8.00×10^{-6} C, the intensity of the electric field is

A. 1.60×10^{-5} N/C
B. 3.20×10^{-5} N/C
C. 1.44×10^{5} N/C
D. 2.88×10^{5} N/C

15. The diagram that best represents the electric field around two oppositely charged spheres is

A.



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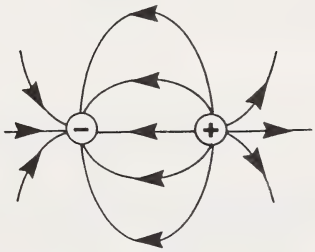

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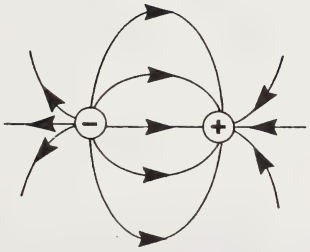

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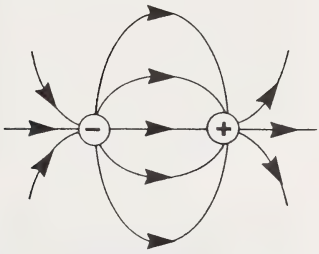


16. The product of potential difference and current is

A. power in J/s
B. work in J/s
C. power in J
D. work in J

17. What maximum speed does a nonrelativistic proton attain when accelerated from rest by a potential difference of 1.50×10^{5} V?

A. 2.40×10^{-14} m/s
B. 1.87×10^{-6} m/s
C. 5.36×10^{6} m/s
D. 2.87×10^{13} m/s

18. If a heating element conducts a 5.0 A current when it radiates heat at a rate of 1.1×10^{3} W, what is the voltage across the element?

A. 44 V
B. 74 V
C. 2.2×10^{2} V
D. 5.5×10^{3} V

19. An average force of 6.00×10^{-3} N is required to move a 4.50×10^{-4} C charge from one point to another point that is 0.750 m away. The potential difference between the two points is

A. 2.03 V
B. 10.0 V
C. 13.0 V
D. 18.0 V

20. The magnitude of the deflecting force that a charged particle experiences when passing perpendicularly through a magnetic field depends upon all of the following EXCEPT the

A. strength of the magnetic field
B. magnitude of the charge
C. velocity of the particle
D. sign of the charge

21. If the beam of high-speed protons produced by a cyclotron is equivalent to a current of 3.2×10^{-3} A, the number of protons that will leave the cyclotron each second is

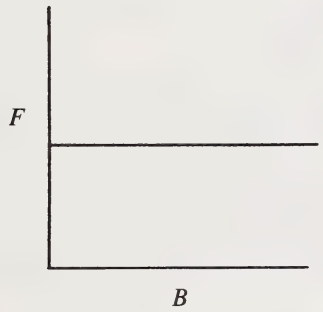
A. 2.0×10^{16}
B. 6.3×10^{18}
C. 2.0×10^{21}
D. 5.1×10^{22}

22. A proton moving perpendicularly across a magnetic field at a speed of 2.0×10^{5} m/s experiences a deflecting force of 3.2×10^{-14} N. The strength of the magnetic field is

A. 32 T
B. 2.0 T
C. 1.6 T
D. 1.0 T

23. A wire that carries a constant current is placed perpendicularly in a magnetic field. The magnetic field B is varied, and the force F is measured. The graph of F as a function of B can be represented by

A.



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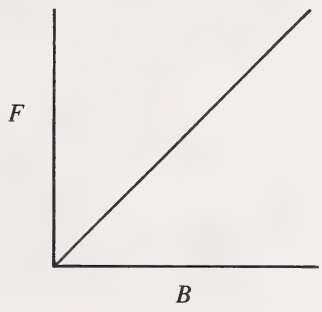

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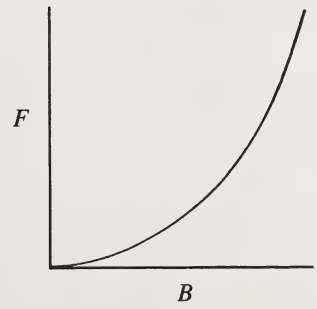

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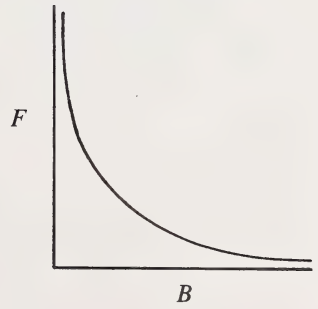
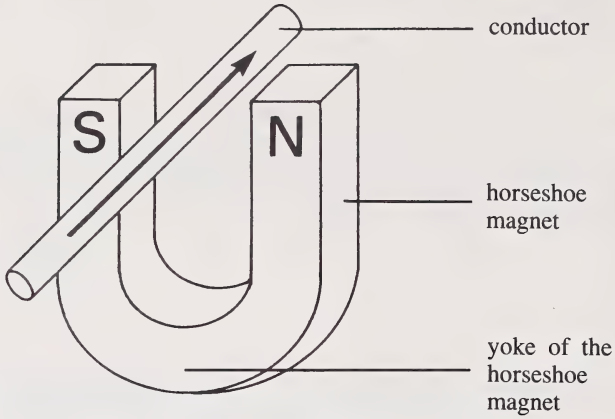


Use the following information to answer question 24.

Electrons flow in the direction indicated through a copper conductor located midway between the poles of a horseshoe magnet.



24. If the conductor is free to move, it will be forced

A. toward the S pole of the magnet
B. toward the N pole of the magnet
C. downward, toward the yoke of the magnet
D. upward, away from both poles of the magnet

Use the following information to answer question 25.

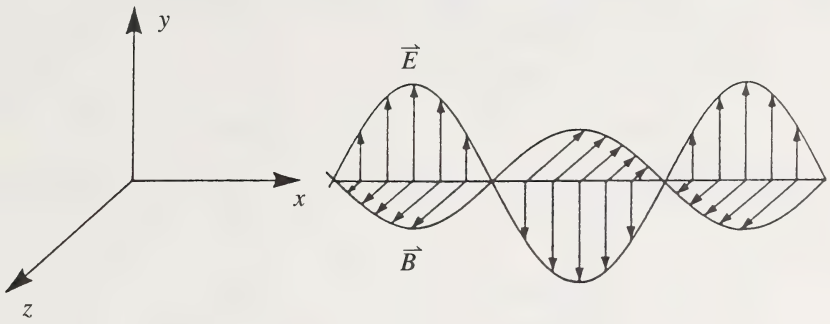
Principles of Electromagnetism

I. A current is induced in a conductor that moves across an external magnetic field.
II. A changing magnetic field in space produces an electric field.
III. An electric current in a conductor produces a magnetic field around the conductor.
IV. A changing electric field in space produces a magnetic field.

25. The principles established by Maxwell are

A. I and II
B. II and III
C. II and IV
D. III and IV

Use the following information to answer question 26.



This diagram shows the directions of the electric and magnetic fields in an electromagnetic wave.

26. What is the direction of motion of the wave?

A. x-direction
B. y-direction
C. z-direction
D. Perpendicular to x and to y

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27. It is observed that lightning affects AM radios more than FM radios. The hypothesis most worthy of further study is that

A. AM signals have lower energy than FM signals
B. interference due to lightning changes the frequency of radio waves
C. interference due to lightning changes the amplitude of radio waves
D. AM signals do not carry as well over a long distance as do FM signals

28. Successive crests of an electromagnetic wave travelling in a vacuum are detected at intervals of 1.0×10^{-6} s. The wavelength of this radiation is

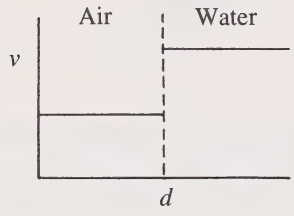
A. 3.0×10^{14} m
B. 3.0×10^{8} m
C. 3.0×10^{5} m
D. 3.0×10^{2} m

29. If a radio wave with frequency f and wavelength λ in air enters a new medium and its speed changes to two-thirds of its speed in air, then its

A. frequency will change to $2f/3$
B. frequency will change to $3f/2$
C. wavelength will change to $2\lambda/3$
D. wavelength will change to $3\lambda/2$

30. The graph that best illustrates the speed v of an electromagnetic wave as it passes from air to water is

A.



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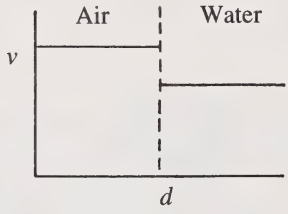
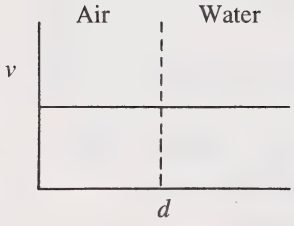
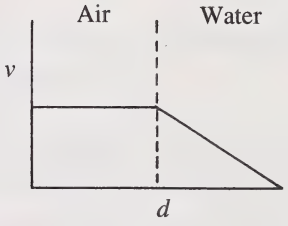


C.



D.



31. Radio waves are MOST like waves and LEAST like particles in that they

A. can exert pressure
B. carry energy from one place to another
C. can travel through the vacuum of space
D. diffract around objects such as trees or houses

Use the following information to answer question 32.

This table shows the results of an experiment in which the minimum wavelength of the X-rays produced by an X-ray machine is related to the voltage of the machine.

Potential Difference (kV)	Minimum Wavelength (nm)
10	0.13
12	0.10
15	0.083
18	0.069
21	0.059

32. The independent (manipulated) and dependent (responding) variables respectively are

A. wavelength and frequency
B. potential difference and voltage
C. wavelength and potential difference
D. potential difference and wavelength

---

33. A microwave has a frequency of 6.20×10^8 Hz. While passing through a glass block, the microwave has a wavelength of 0.205 m. The refractive index of the glass block is

A. 10.1
B. 2.36
C. 2.07
D. 0.993

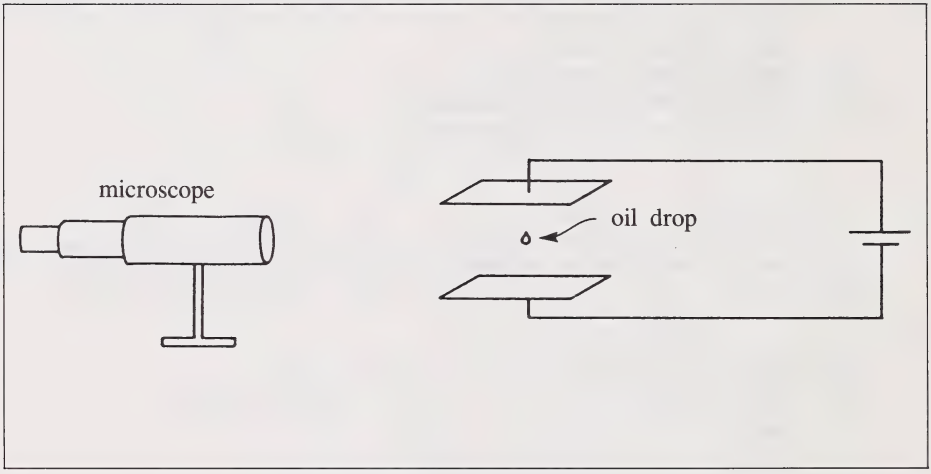
Use the following information to answer question 34.

The "jamming" of electromagnetic waves is an interference phenomenon. During the Second World War, bombers dropped aluminum foil strips that had been cut to half the wavelength of the radar waves they were jamming.

34. If the aluminum foil strips were 40.0 cm long, the frequency of the radar waves they were jamming was

A. 7.50×10^8 Hz
B. 3.75×10^8 Hz
C. 7.50×10^6 Hz
D. 3.75×10^6 Hz

Use the following information to answer question 35.



35. Which equation is associated with the apparatus in the diagram?

A. $q_e|\vec{E}| = mg$

B. $E_{k(max)} = q_e V_{stop}$

C. $q_e|\vec{E}| = q_e vB$

D. $q_e vB = mv^2/r$

---

36. An experiment in which 32.0 g of chromium are deposited by a 4.0 A current flowing for 12.4 h indicates that the combining capacity (valence) of chromium is

A. 1
B. 2
C. 3
D. 4

Use the following information to answer question 37.

A physicist in a remote part of the galaxy measured charges on an oil droplet by using a procedure similar to that used by Millikan. The measurements were:

2.5×10^{-19} C 4.0×10^{-19} C 1.0×10^{-19} C
2.0×10^{-19} C 3.5×10^{-19} C 3.0×10^{-19} C

37. According to these results, the physicist would predict the smallest unit of charge to be

A. 1.0×10^{-19} C
B. 5.0×10^{-20} C
C. 2.5×10^{-20} C
D. 1.0×10^{-20} C

---

38. Singly charged ions of sodium, potassium, and rubidium enter perpendicularly into a magnetic field. If the ions have the same speed, which statement below would best describe the relationship between the radii of the curved paths of the particles?

A. The path of the sodium ions has a larger radius than the path of the rubidium ions.

B. The path of the sodium ions has a larger radius than the path of the potassium ions.

C. The path of the potassium ions has a larger radius than the path of the sodium ions.

D. The path of the potassium ions has a larger radius than the path of the rubidium ions.

39. If an electron passes undeflected through perpendicular electric and magnetic fields with strengths of 2.0×10^4 N/C and 1.0×10^{-2} T respectively, its speed is

A. 2.3×10^5 m/s
B. 5.0×10^5 m/s
C. 2.0×10^6 m/s
D. 1.7×10^7 m/s

40. The maximum frequency of X-rays emitted from a cathode-ray tube that operates at a potential difference of 2.0×10^4 V is

A. 1.6×10^{19} Hz
B. 4.8×10^{18} Hz
C. 9.7×10^{17} Hz
D. 1.6×10^{17} Hz

41. Blue light with a wavelength of 4.70×10^{-7} m is shone onto a photoelectric cell that has a work function of 2.00 eV. The maximum kinetic energy of the photoelectrons is

A. 1.03×10^{-19} J
B. 2.23×10^{-19} J
C. 4.23×10^{-19} J
D. 7.43×10^{-19} J

42. A quantum of electromagnetic radiation is called

A. a proton
B. a photon
C. an electron
D. a photoelectron

43. The most baffling phenomenon in classical physics concerning the photoelectric effect was that

A. the beams produced could not be polarized

B. the photoelectric current, once observed, was proportional to the intensity of the incident light

C. the polarity of the emitted current could be reversed by adjusting the frequency of the incident light

D. no electrons were emitted regardless of the intensity of incident light, unless the light was of a certain minimum frequency

44. The quantity that remains constant for an ion that accelerates to a relativistic speed is its

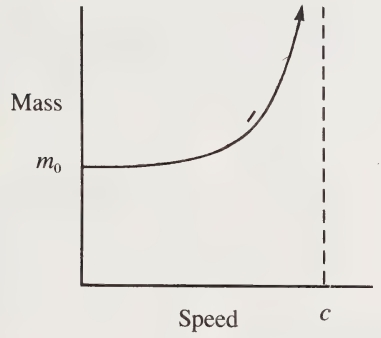
A. mass
B. radius
C. energy
D. charge

45. When an object with a rest mass of 2.2×10^{-20} kg has a relativistic mass of 3.4×10^{-20} kg, its kinetic energy is

A. 3.1×10^{-3} J
B. 1.5×10^{-3} J
C. 1.1×10^{-3} J
D. 9.9×10^{-4} J

46. The graph that BEST illustrates the relationship between the mass and the speed of an object is

A.



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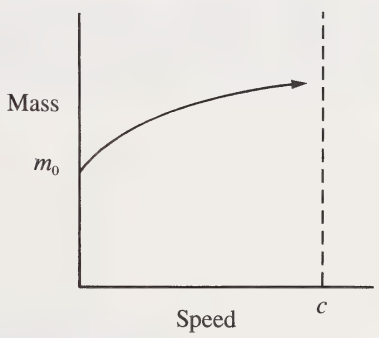
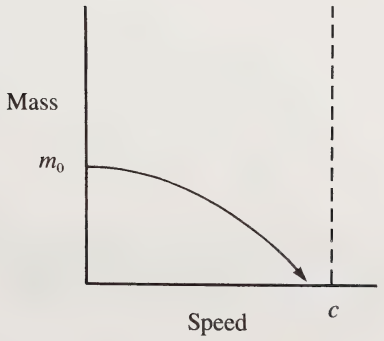


C.



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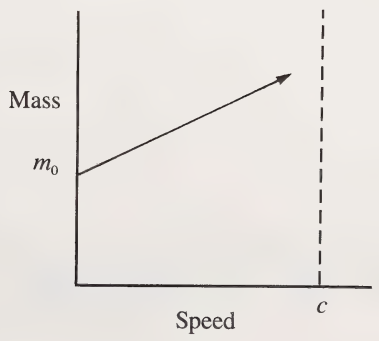

47. In Compton's X-ray scattering experiment, the analysis of the collision of X-ray photons with electrons involves the use of the law(s) of the conservation of

A. energy only
B. momentum only
C. both momentum and energy
D. neither momentum nor energy

48. A beam of alpha particles is diffracted from a lithium fluoride crystal in which ions are separated by 2.0×10^{-9} m. The first-order diffraction maximum occurs at an angle of 8.0°. The speed of the alpha particles in the beam is

A. 2.1×10^{2} m/s
B. 3.6×10^{2} m/s
C. 5.0×10^{2} m/s
D. 1.4×10^{3} m/s

49. The term ''probability distribution'' is used in the discussion of the

A. Compton effect
B. duality of particles and waves
C. position of an electron in an atom
D. energy levels of the hydrogen atom

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough-work.

TOTAL MARKS: 21

START PART B IMMEDIATELY

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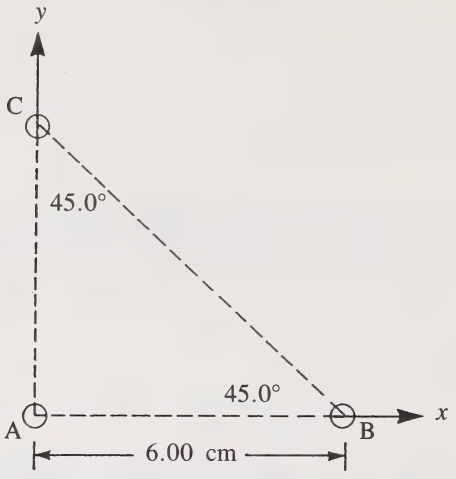
Use the following information to answer question 1.



All three objects are positively charged.

(4 marks)

1. a. Given that the charges on A and B are each of magnitude 3.00×10^{-6} C, and that the charge on C is of magnitude 4.00×10^{-6} C, determine the magnitude AND direction in degrees of the net force acting on object A.

FOR DEPARTMENT USE ONLY

b. Illustrate the answer to part a. with an appropriate sketch.

(1 mark)

FOR DEPARTMENT USE ONLY

2. A hypothetical atom has an energy of -18.5 eV in its first energy level. Other energy levels are related to this level by the formula

$$E_n = E_1/n^3$$

(Note: This formula is NOT the Bohr formula.)

(1 mark)

a. Calculate the energy of an electron in the fourth energy level.

(3 marks)

b. Calculate the wavelength of the photon emitted when an electron makes a transition from the fourth to the second energy level.

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c. Using your own answer to part b., which region of the electromagnetic spectrum contains this wavelength? (ONLY if you were unable to calculate a wavelength in part b., use the hypothetical value of 4.85×10^{-7} m.)

(1 mark)

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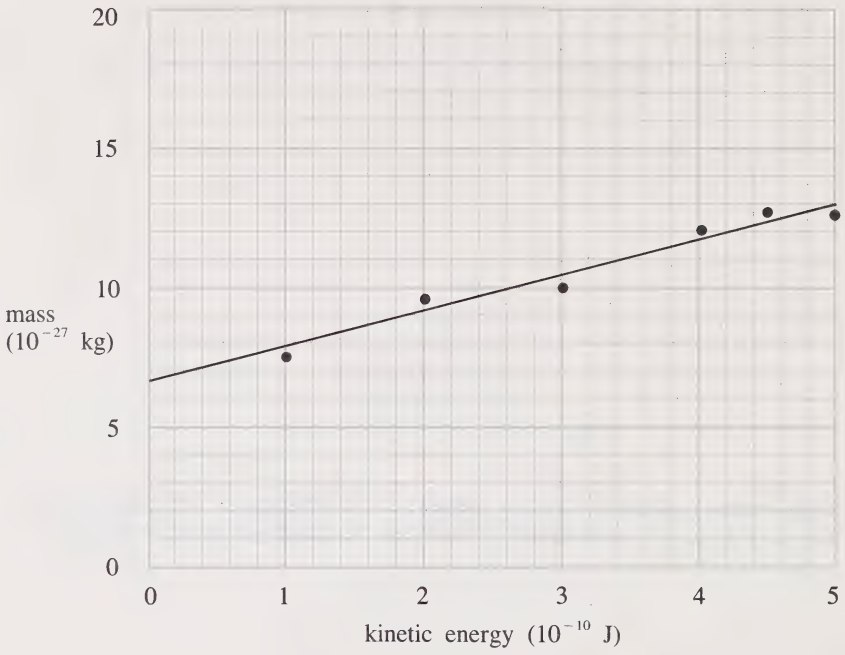
Use the following information to answer question 3.



The graph represents the mass m of a particle as a function of its kinetic energy E_k. The formula relating E_k and m is $E_k = (m - m_0)c^2$.

(2 marks)

3. a. Calculate the slope of the graph.

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b. Use the slope of the graph to determine the speed of light. **(2 marks)**

c. Use the intercept on the vertical axis to name the particle used in this experiment. **(1 mark)**

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Use the following information to answer question 4.

A student notices the yellow appearance of a banana in white light and suggests three hypotheses to account for the observation:

1. All wavelengths are absorbed except for yellow, which is reflected.
2. All wavelengths are absorbed except for green and red, which are reflected, and these combine to appear yellow.
3. All wavelengths are absorbed except for orange, yellow, and green, and of these three, yellow is by far the most predominant reflected color.

The student wishes to test all three hypotheses. All other possible hypotheses have already been rejected.

4. The student performs an appropriate experiment using a white light source and some or all of the following PURE color filters: yellow, red, orange, green, blue.

(1 mark)

a. If hypothesis 1 is correct, describe the student's observations in the experiment.

(2 marks)

b. If hypothesis 2 is correct, describe the student's observations in the experiment.

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c. If hypothesis 3 is correct, describe the student's observations in the experiment. **(3 marks)**

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

TEAR-OUT SHEET

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M1 M2 M3 M4

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PHYSICS 30

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PHYSICS 30